Project ID: EEMS047

U.S. DEPARTMENT OF ENERGY

SMARTMOBILITY

Systems and Modeling for Accelerated Research in Transportation

Estimate the energy impact of new mobility technologies on personal travel modes in the San Francisco Bay Area

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2017 VTO Annual Merit Review

June 19, 2018

Argonne NATIONAL LABORATORY

INL Idaho National Laboratory

BERKELEY LAB

OAK RIDGE National Laboratory

NREL NATIONAL RENEWABLE ENERGY LABORATORY

ENERGY EFFICIENT MOBILITY SYSTEMS PROGRAM
INVESTIGATES

MOBILITY ENERGY PRODUCTIVITY

THROUGH FIVE EEMS ACTIVITY AREAS

Advanced R&D Projects

Living Labs

Smart Mobility Lab Consortium

HPC4Mobility & Big Transportation Data Analytics

Core Evaluation & Simulation Tools

Advanced Fueling Infrastructure

Connected & Automated Vehicles

Urban Science

SMART MOBILITY LAB

CONSORTIUM

7 labs, 30+ projects, 65 researchers,
$34M* over 3 years.

Mobility Decision Science

Multi-Modal Transport

*Based on anticipated funding

Overview

Timeline

- Start date: 10/2016
- End date: 09/2019
- Percent complete: 50%

Budget

- Total funding: $625k
  - DOE share: 100%
- FY 2017: $*175k*
- FY 2018: $200k

Partners

- Project Lead: LBNL
- Partners: LBNL, UC Berkeley, Conveyal, Stanford

Barriers

- Modal distribution has a large impact on energy consumption
- Mode shifting is sensitive to the cost and performance of the system and traveler-specific context, requiring full modal representation to accurately assess
- Detailed ride hailing data are limited in most U.S. cities
- It is difficult to observe from transit ridership data the extent to which TNCs are acting as direct substitutes versus facilitating access to transit.

Objectives, Relevance, and Milestones

- Understand the energy implications of shifts in personal travel among conventional transit and other emerging transportation modes:
  - the degree to which TNCs change public transit use
  - the impacts of transit system improvements or degradations
- It is difficult to observe from transit ridership data the extent to which TNCs are acting as direct substitutes versus facilitating access to transit. Through simulation, this task will directly assess the ridership and energy impacts of a system with and without various TNC/transit configurations, a goal of EEMs.

Milestones

Date	Milestone	Status
September 2017	Enhance model to simulate the effect of sectoral changes on modal composition and energy use	Complete
September 2018	Estimate effect of short-term influences, such as pricing schemes, transit expansion/electrification, and TNC/transit coupling, on energy use	On track

Approach: Systems Modeling

- Enhance BEAM to allow the estimation of VMT and system energy use from short-term scenarios including
  - using TNC for first/last mile service to link with public transit
  - with and without surge priced TNCs
  - changes to cost and supply of TNCs and public transit
- Develop scenarios to simulate transit improvements
  - increased light rail capacity
  - bus rapid transit

Credit: https://commons.wikimedia.org/wiki/File:Slussen_Stan_May_2015.jpg
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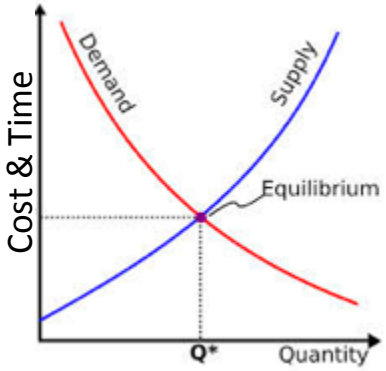
Technical Accomplishments Summary

- Refined several modal representations in BEAM:
  - Walk
  - Bike
  - Driving
  - Walk to Transit / Drive to transit
  - Ride hailing
- Assembled San Francisco Bay Area database of transit feeds and transit energy characteristics
- Ran various sensitivity studies

BEAM simulates Resource Markets

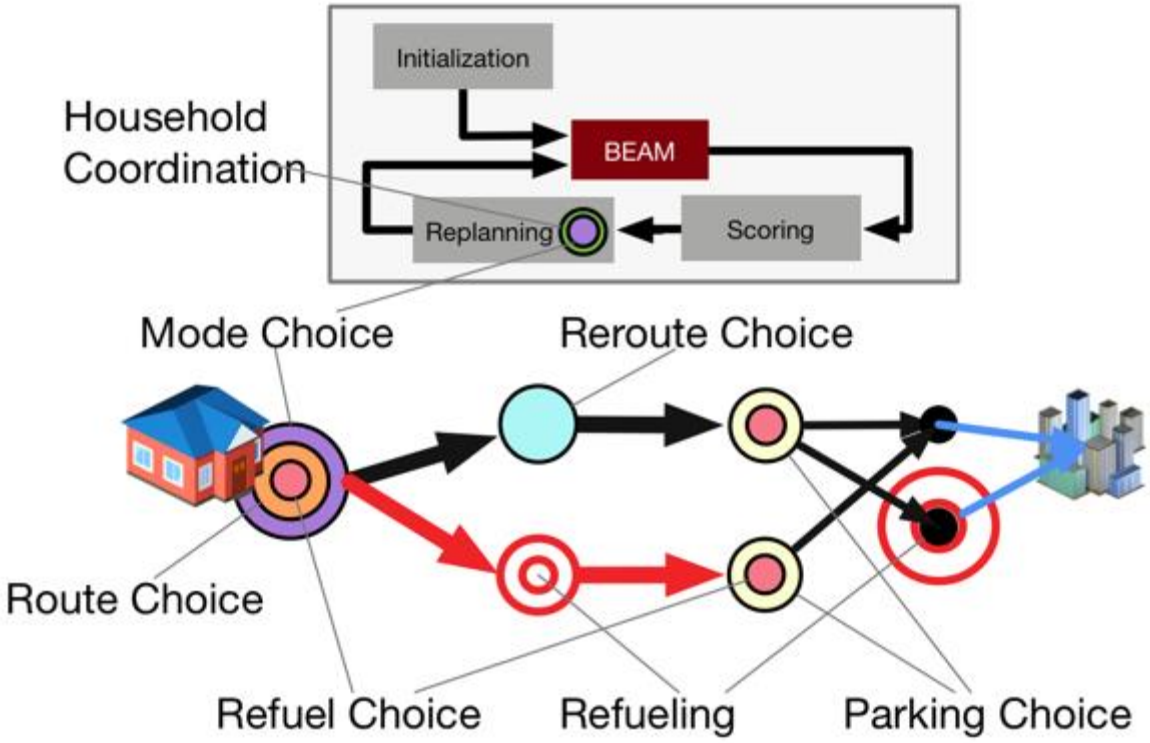
- Since AMR ’17, we added new resource markets to BEAM:
  - Road Capacity
  - Vehicle Capacity
  - Parking/Refueling Access
  - TNC Availability (enhanced previous solution)



- These markets are composed of:
- Supply:
  - Driving
  - Transit
  - Intermodal (drive to transit)
  - Walk / Bike
  - TNC (centrally managed)
  - Parking
- Demand (governed by behaviors):
  - Mode Choice
    - Price & Time Sensitive
  - Route Choice
    - Multimodal
  - Rerouting
  - Parking Choice

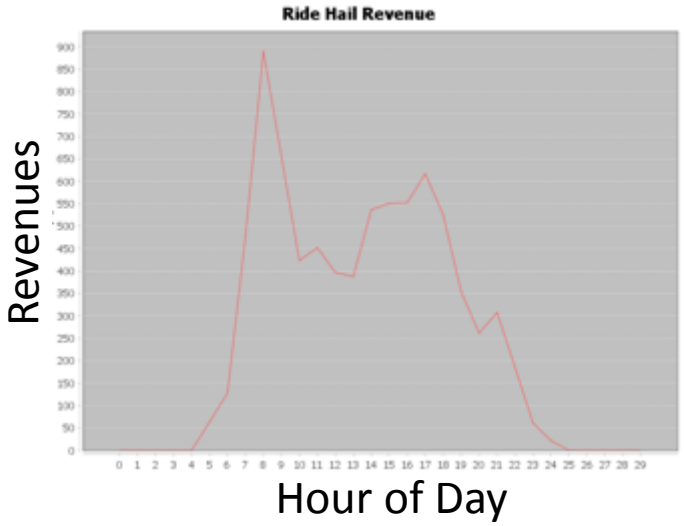
Behavioral Modeling in BEAM

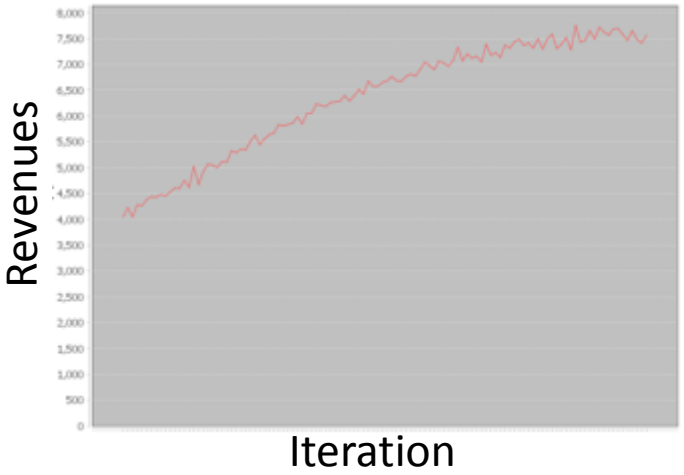
- Person agents make decisions during replanning (i.e. before the day begins) as well as throughout their day including:
  - At the point of departure: mode choice, route choice
  - During trips: rerouting, parking, and refueling (under development)

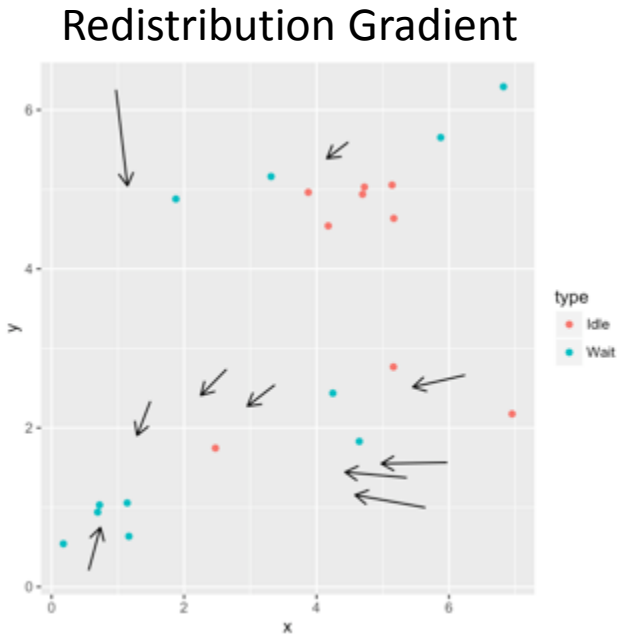


Surge Pricing and Redistribution

- Ride hailing operator can iteratively adjust price in each TAZ to maximize revenues or minimize wait time
- Surge price will be used primarily in choice model of ride hailing agents to enter the market
- Ride hail taxis are redistributed according to iterative learning algorithm that minimizes customer wait times







Scenario and Analyses

Scenarios

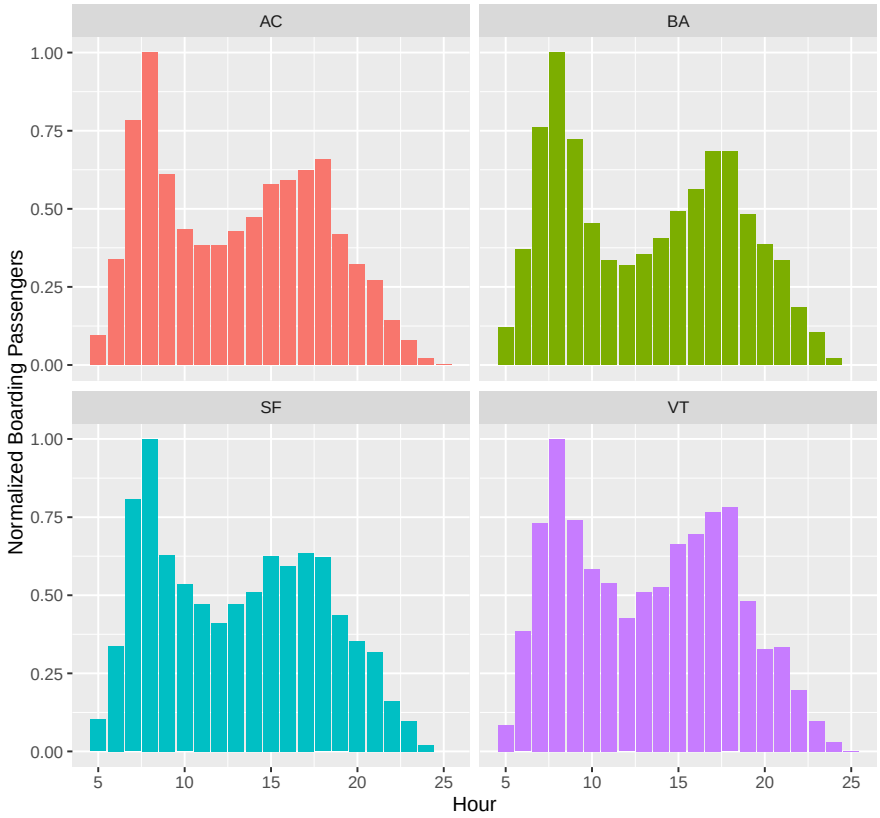
- San Francisco Only Scenario
  - 3% Sample (25k person, 26k vehicles, 500 TNC fleet, Muni + BART)
- Full Bay Area Scenario
  - 5% Sample (~400k persons, 340k cars)
  - Full Transit (27 agencies, 828 routes)
  - TNC Fleet (20,000 - also referred to as Ride Hailing)

Analyses:

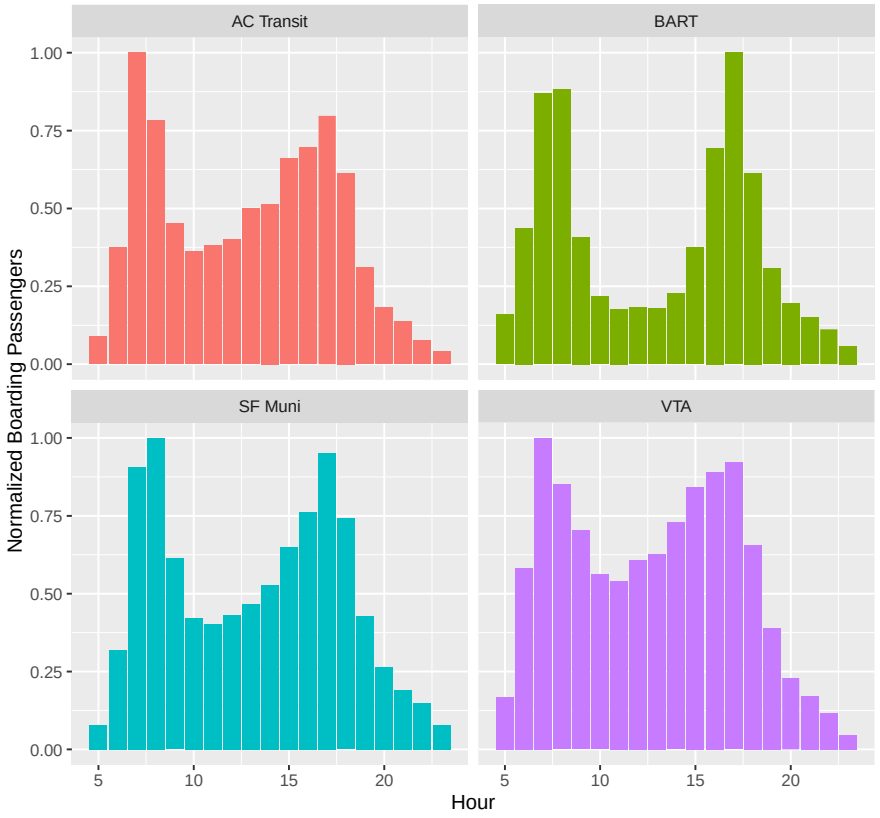
- Validation – Full SF Bay
- Transit Price – SF Only
- Transit Capacity – SF Only
- TNC Price – SF Only
- TNC Number – SF Only
- Losing Transit Service – Full SF Bay
- Surge Pricing – SF Only

Preliminary Validation

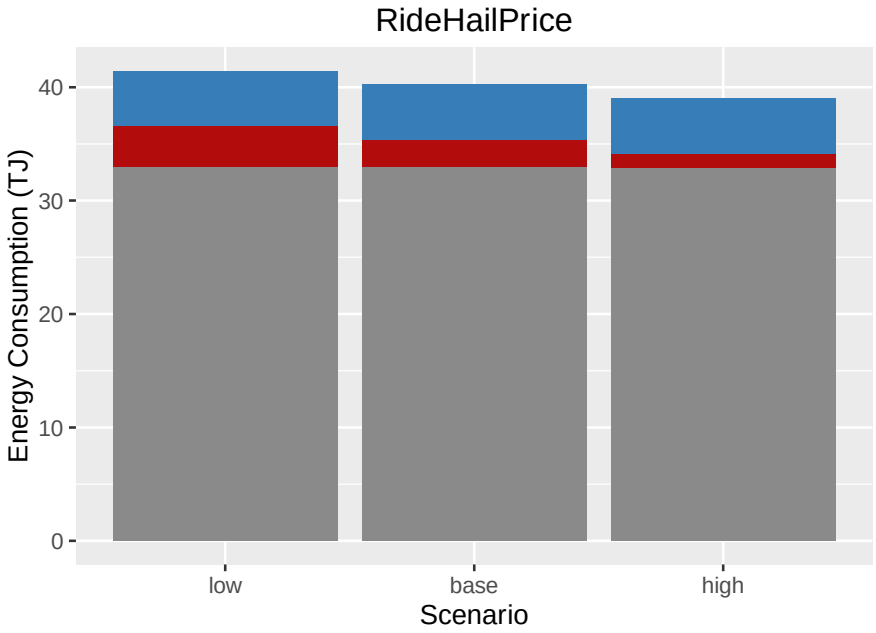
Modeled: BEAM

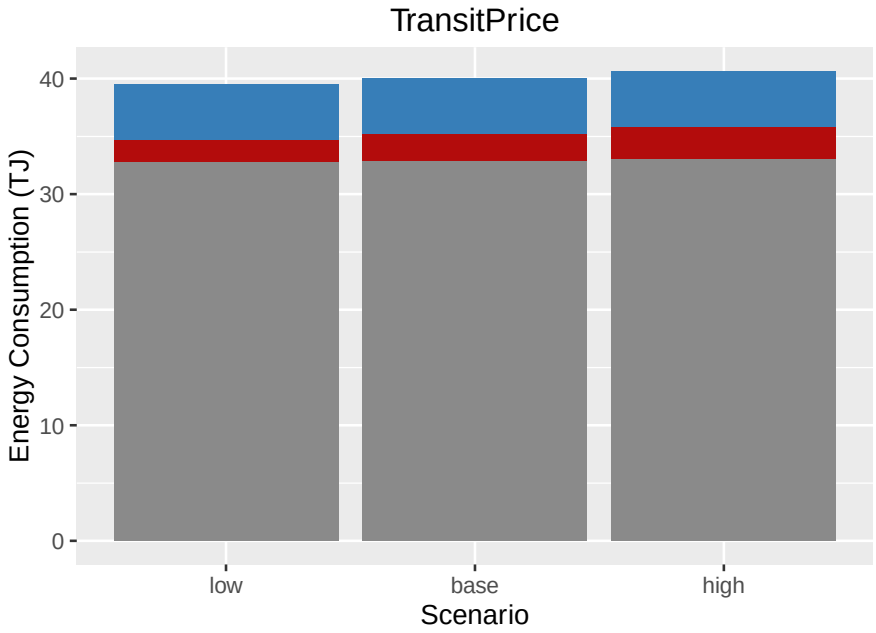


Observed: Clipper



Price Sensitivities





Scenarios:

- Low -25%
- Base
- High +25%

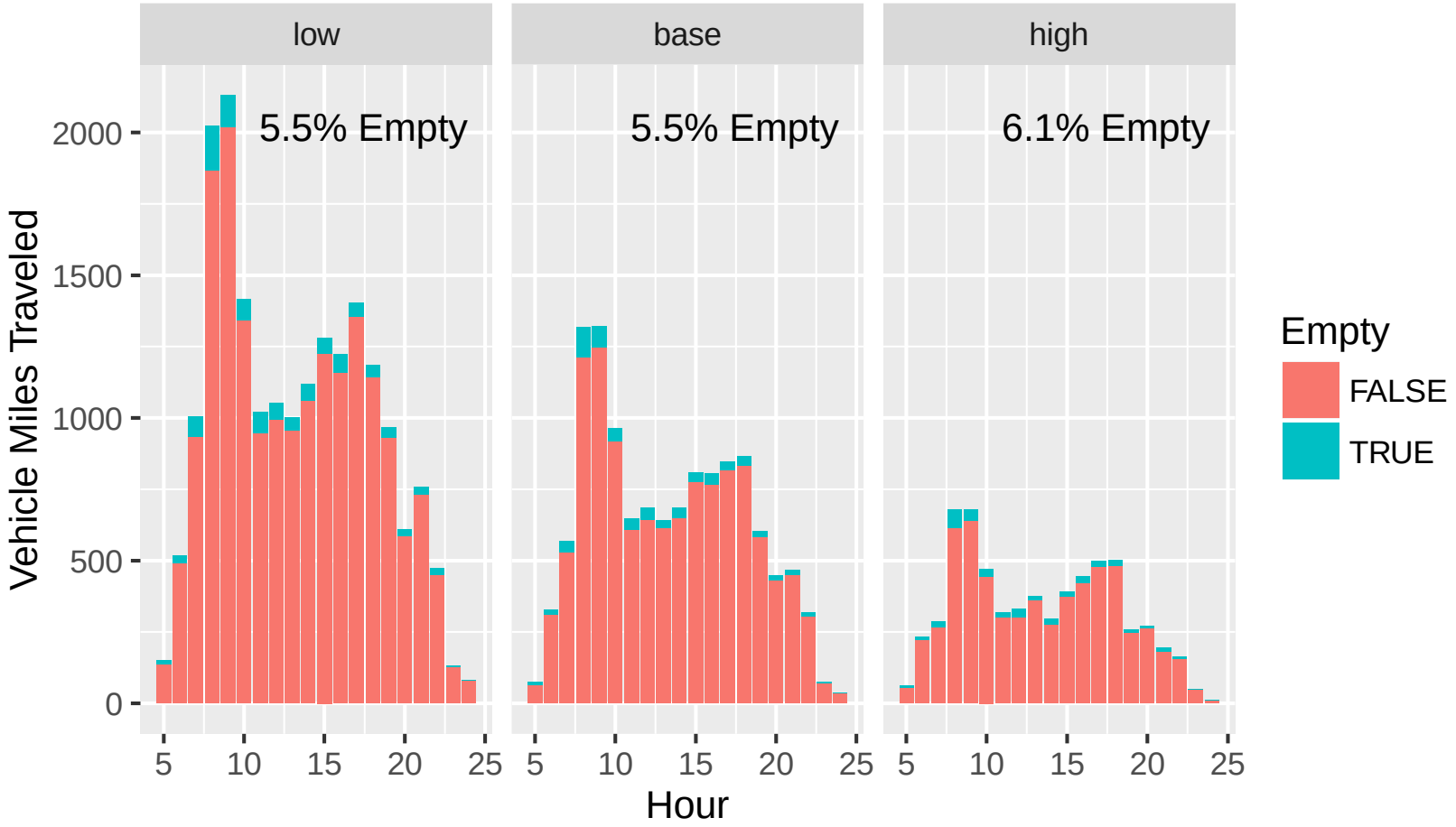
Trip Mode

- Car
- TNC
- Transit
- Walk

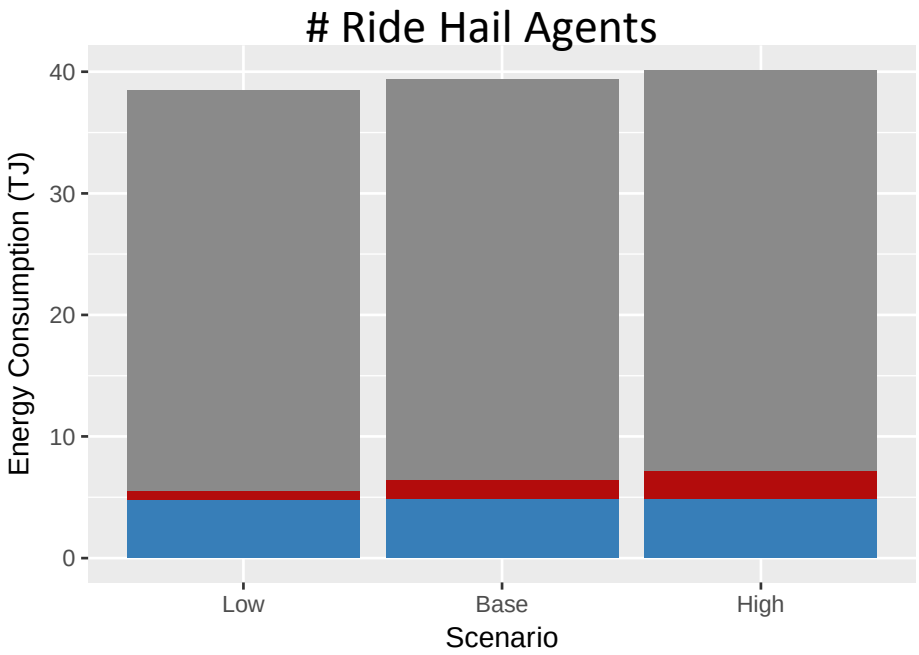
Scenarios:

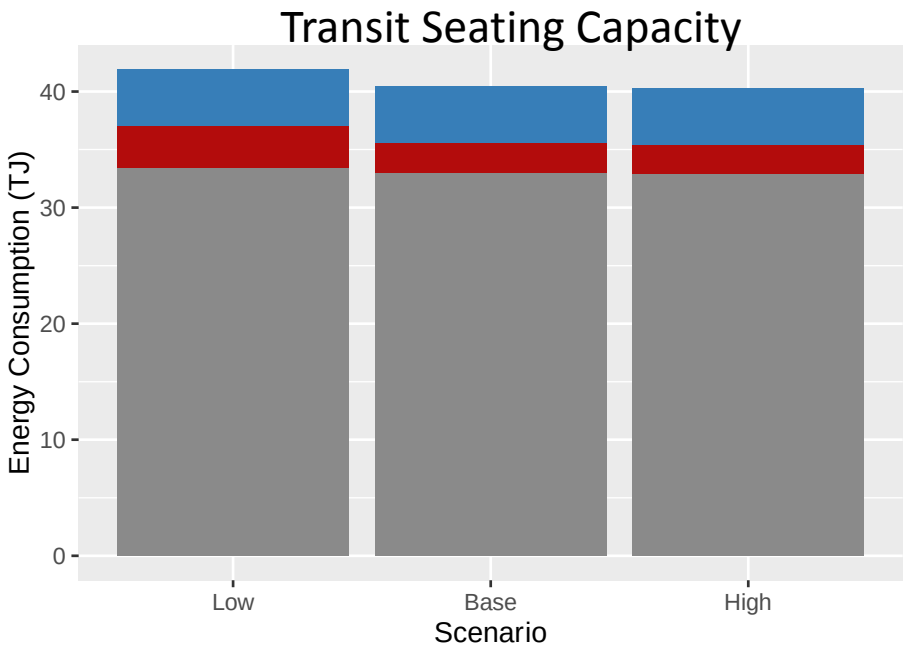
- Low -50%
- Base
- High +50%

Deadheading vs Price of TNCs



TNC and Transit Capacities





Scenarios:

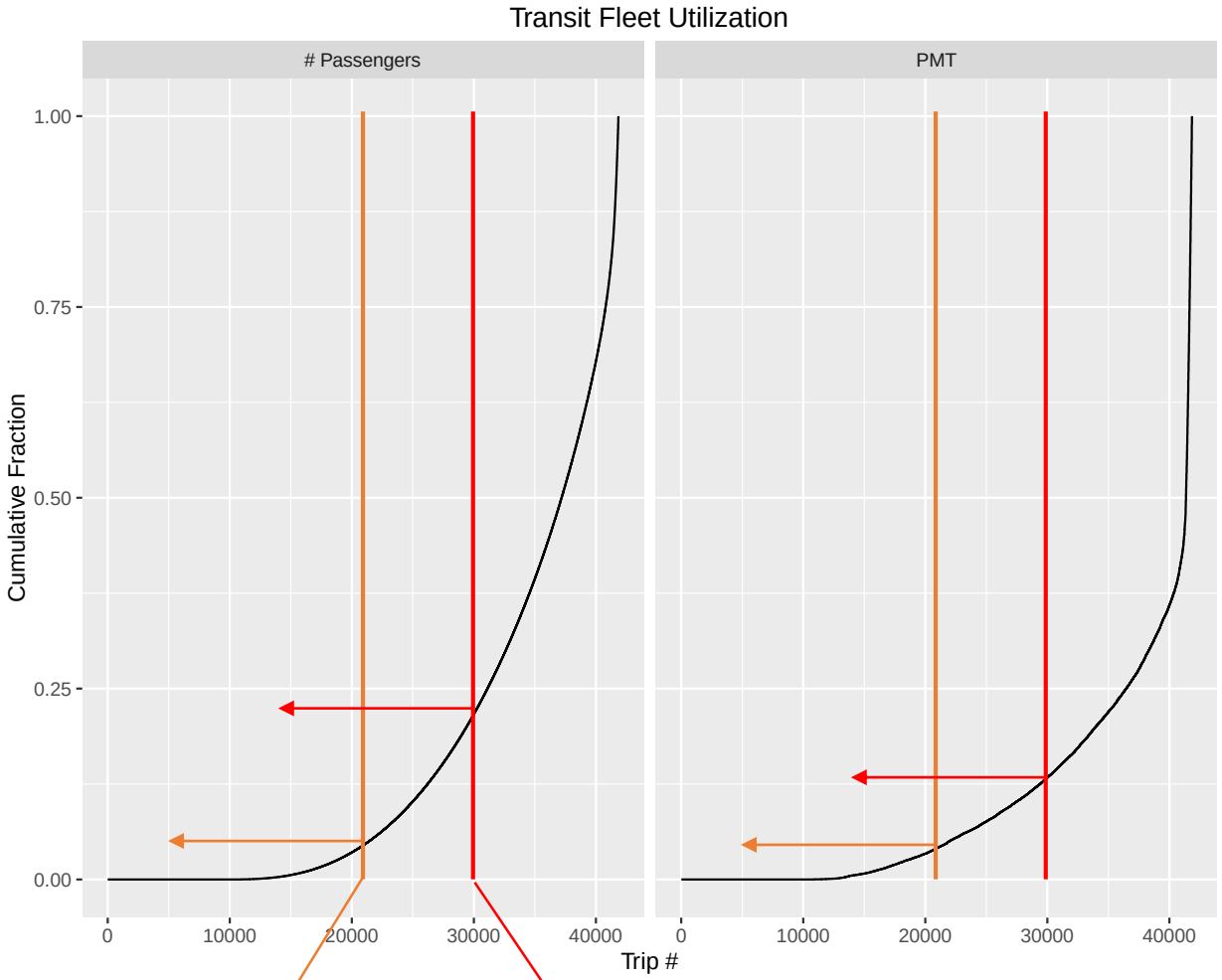
- Low -66%
- Base
- High +66%

Trip Mode

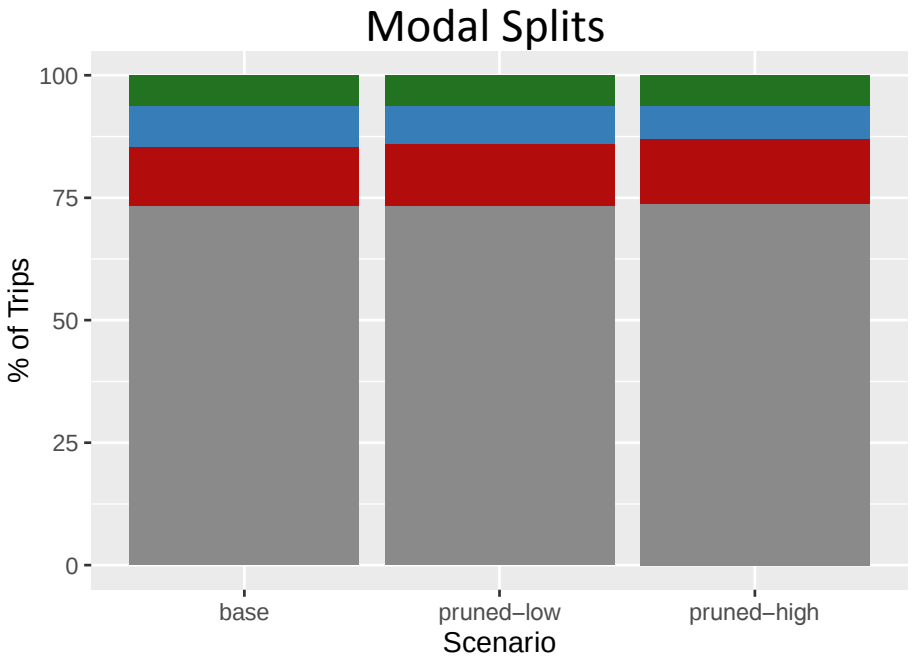
- Car
- TNC
- Transit
- Walk

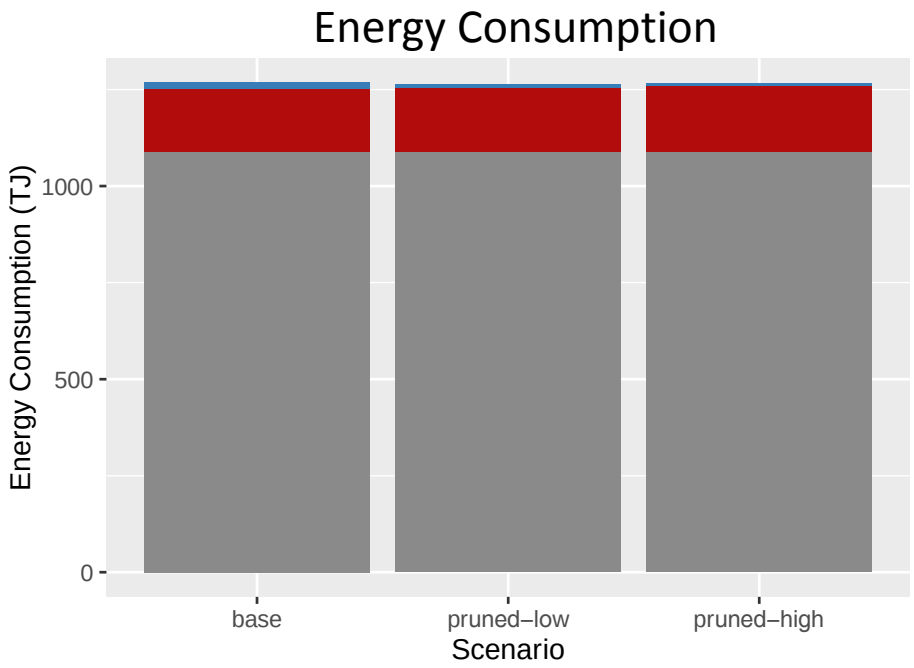
Impact of Losing Transit Service

- What if low ridership transit lines are supplanted by low cost TNCs?
- To investigate, we analyze transit ridership in a base scenario, and delete low-ridership trips from the GTFS schedules



Impact of Losing Transit Service





Scenarios:

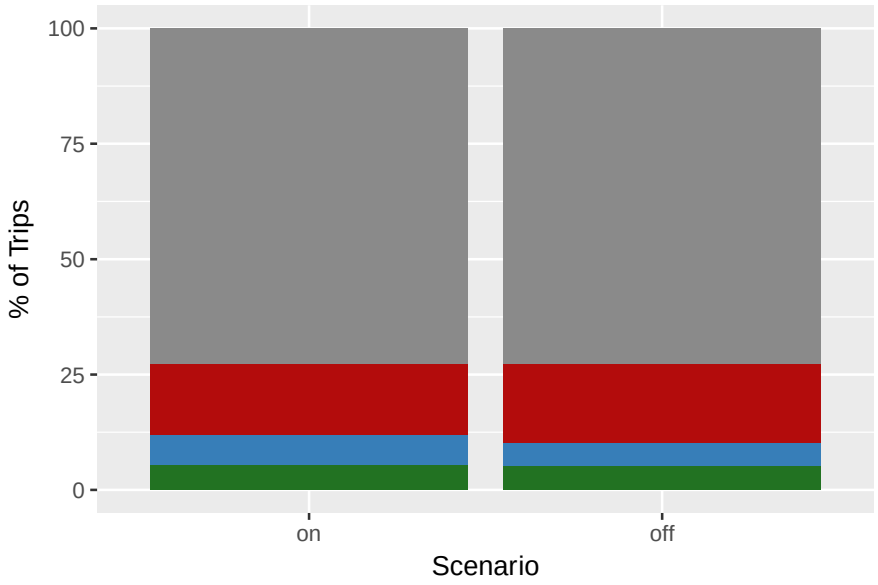
- Base
- Pruned-Low ~50% trips
- Pruned-High ~75% trips

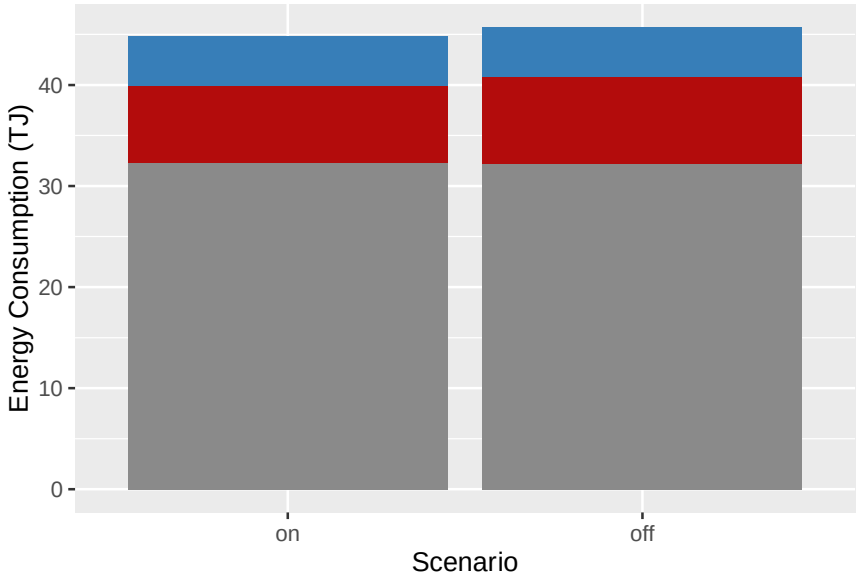
Trip Mode

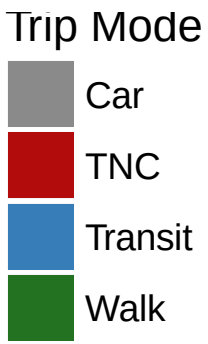
- Car
- TNC
- Transit
- Walk

- Energy consumption largely unchanged as low / no-passenger transit vehicles are replaced by light duty vehicles
- Marginal impacts on modal split
- TNC predominant replacement to missing transit services

Impact of Surge Pricing







- Using multinomial logit choice model
- Surge pricing reduces TNC share by 2 percentage points
- Of those no longer using TNC: 80% shift to Transit, 15% to walking, 5% to car
- Surge pricing decrease energy consumption by 2%

Response to FY17 Reviewers

This Project was not reviewed in FY17

Collaborations

conveyal

- Authors of open source R5 multimodal routing software
- Assisting with integration of router into BEAM
- Assisting with transit data feed editing tools

Stanford University

- Developing ride hailing fleet optimization schemes for customer matching, rebalancing, and EV charging to deploy within BEAM

Remaining Challenges

- Navigate balance between larger scale runs versus smaller scale but more runs capable of exploring more sensitivities and scenarios
- Ride hailing lack of data
  - –Using best available currently, exploring better options
- Developing robust scenarios for analyzing changes to transit system

Remaining Work

FY18 Remaining Work

- Complete model enhancements:
  - Allow TNC for first/last mile service to public transit
  - Enable TNC fleets to rebalance according to customer wait time minimization heuristic
- Develop scenarios to simulate transit improvements / degradations:
  - increased light rail capacity
  - bus rapid transit
  - parking accessibility
  - curtailments in transit service
- Conduct analysis of impacts with above enhancements in placef

FY19 Future Work

- Study impact of long-term system changes on energy use, e.g.:
  - Major changes to transit system (new stations, routes, schedule increases)
- Study connection between transportation mega-trends and land use

ANY PROPOSED FUTURE WORK IS SUBJECT TO CHANGE BASED ON FUNDING LEVELS

Summary

- It is difficult to observe from transit ridership data the extent to which TNCs are acting as direct substitutes versus facilitating access to transit.
- This task will directly assess the ridership and energy impacts of a system with and without various TNC/transit configurations.

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QUESTIONS?

Technical Back-Up Slides